



National Aeronautics and Space Administration

July 6, 1998

NRA-98-OES-09

RESEARCH ANNOUNCEMENT

**Remote Sensing Applications Research
in
Agriculture, Forestry, and Range Resources Management**

Letters of Intent Due July 27, 1998

OMB Approval No. 2700-0087

**Remote Sensing Applications Research
in
Agriculture, Forestry, and Range Resources Management**

**NASA Research Announcement
Soliciting Research Proposals
for
Period Ending
September 8, 1998**

**NRA 98-OES-09
Issued July 6, 1998**

**Office of Earth Science
National Aeronautics and Space Administration
Washington, DC 20546**

1. Purpose

The National Aeronautics and Space Administration (NASA) Earth Science Enterprise (ESE; formerly the Mission to Planet Earth) seeks to develop an understanding of the total Earth system and the effects of natural and human-induced changes on the global environment (<http://www.hq.nasa.gov/office/mtpe/>). This goal is being pursued through a program of research and analysis that explores the use of remotely sensed data for detecting and evaluating environmental status and change at regional (local, county, state, and country) and global scales. The understanding that emerges from this research is intended to enable remote sensing data to be used to inform decisions regarding public and private resource management.

The purpose of this NASA Research Announcement (NRA) is to solicit research proposals in natural resource management focusing on agriculture, forestry, and ranges. The goal of this solicitation is to further the scientific understanding of the near-term potential of ESE research, data and attending technologies, e.g., Geographic Information Systems (GISs), for solving specific problems. To this end, the solicitation seeks to develop, test and validate applications of ESE science and data to high-priority problems in cooperation with representative organizations and/or individuals in these sectors.

The total amount of funds available for this program is \$6 million. Individual grants will not exceed \$200 thousand per year. Proposals will be considered for periods of performance of three years.

2. Background

This NRA is the first in a planned series of cooperative research programs aimed at extending the use of Earth science research to national, state and local applications. This particular NRA is dedicated to exploring the ways in which NASA's remote sensing science and data might be applied to agriculture, forestry, ranges, and natural resource management. The goal is to accelerate the movement of remote sensing research results and data into the operational arena.

The background for this NRA was developed at the Workshop on Remote Sensing Science for Agriculture in the 21st Century held at the University of California at Davis during October 23 - 25, 1996. The NRA is also one of several activities which have resulted from the Memorandum of Understanding (MOU) signed by Secretary Dan Glickman of the U.S. Department of Agriculture (USDA) and Mr. Dan Goldin, Administrator of NASA. The purpose of the MOU is to provide the framework for and enhance the cooperative activities between NASA and USDA in the areas of joint science and applications research, and technology transfer concerning agriculture and related discipline areas. In addition, a focus on agriculture, forests, ranges, and natural resource management is also consistent with the overall ESE commitment to support the U.S. Global Change Research Program (USGCRP; <http://www.usgcrp.gov>) which has identified these sectors as key areas of concern.

3. Earth Science Applications Research Program Goal

In addition to building improved scientific understanding, ESE contributes to enabling near-term economic and societal payoffs from the public's investment through the Earth Science Applications Research Program (ESARP). The goal of ESARP is to extend the uses of Earth science research, information and products beyond the needs of global change research to a broader user community, including other Federal agencies, state, and

local governments, value-added companies, private sector users, and various non-governmental organizations (NGOs). In this process, ESARP helps to define the needs of the broader user community and identify space assets and science results that can meet those needs.

The objectives of the ESARP are to: (1) to capture and understand the practical Earth Science information needs of the non-science community; (2) to mobilize enterprise-wide expertise in science and technology through a program of Applications Research driven by user needs; (3) to extend the benefits of ESE science results, data and expertise to the broader user community.

This NRA is an integral part of the ESARP and responds to the challenge to develop new methods for bringing together the research, service, and end-user communities to develop and apply ESE science and information to practical problems. In doing so, the NRA also provides a major vehicle to solicit proposals designed to conduct regional assessments in support of and in cooperation with the on-going USGCRP National Assessment.

4. Topical Priorities

The following represent the major topical issues for this NRA; all of equal priority. The three primary areas are:

- Natural Resource (Vegetation) Mapping, Inventory, Characterization and Monitoring
- Risk and Damage Assessment
- Resource Management and Precision Agriculture

4.1 Natural Resource (Vegetation) Mapping, Inventory, Characterization, and Monitoring

4.1.1 Crop type mapping area monitoring, and crop condition assessment

Remote sensing has been applied to the area of crop identification and area measurement since the 1930's. Yet, there is a need to more efficiently and effectively: (1) identify important agricultural crops, (2) map the areal extent of these crops, (3) monitor changes in agricultural patterns and practices at a variety of spatial and temporal scales, and (4) conduct timely and accurate crop condition assessments.

4.1.2 Forest and Range Vegetation Inventory and Characterization

There is a comparable need to improve our ability to inventory and characterize the Nation's forest and rangeland resources. As above, application of advanced remote sensing techniques might be used in (1) forest and range inventory and characterization, but might also include, (2) watershed and fire fuels characterization, (3) wildlife habitat analysis, and (4) determination of rangeland carrying capacity.

4.1.3 Soil Landscape Inventory and Monitoring

There is a need to develop remote sensing techniques to characterize the soil landscapes of the U.S. Remote sensing technology has shown potential to be applied to the inventory and monitoring of the nation's soil resources. However, very little practical application has been made of this technology at the field level, which is considered the basic agricultural production unit. Application of advanced remote sensing techniques

might be used to (1) refine and validate existing soil inventories, (2) inventory soil landscapes exclusively with remote sensing, and (3) develop integrated approaches to include soil, vegetation, aquatics, and geology in a terrestrial ecosystem inventory.

4.1.4 Change Detection

The goal of the ESE is to capture and understand how the Earth's environment changes using advanced remote sensing technology. Research here should focus on detecting and understanding changes that are significant to resource managers whether that be the farmer in the field, an environmental planner, forest industry executive, or state or Federal agency personnel. Topics of interest in this area include applications of advanced remote sensing technologies to the study of, (1) deforestation, (2) reforestation, (3) agricultural land use and conversions, or (4) ecological condition and trend in forest lands, wetlands, or rangelands.

4.2 Risk and Damage Assessment

Remotely-sensed data may also be used for the assessment of environmental risks and the assessment of damage caused by a variety of physical, biological, chemical and anthropogenic stresses. The modeling of fire fuel, and the potential soil loss are examples of environmental risks that require assessment. Factors that contribute to the degradation of the quality of a land resource also require study. Damage to agricultural crops, forests and rangelands caused by weather related events such as floods, frost, hail, lightning, wind, drought and hurricanes, are examples of potential areas where the operational use of applied satellite remote sensing technology can be expanded. The improved use of remote sensing for plant disease detection and insect and weed infestation is also appropriate.

4.3 Resource Management and Precision Agriculture

4.3.1 Resource Management

The use of remotely-sensed data as input to resource management decision support models is an important area of study. This encompasses a diverse array of topics from information required to optimize the scheduling of irrigation, applying fertilizer, pest spraying, and harvesting, to the planning of optimal logging operations, to the movement of herds to maximize the use of available forage.

4.3.2 Precision Agriculture

Considerable advances have been made in the area of precision agriculture (site specific farming, variable rate technology, etc.), in merging advanced remote sensing and other geographic technologies. Precision agriculture seeks to tailor soil and crop management to fit specific conditions found within a given field as they vary through time. Various technologies are used to determine crop yields, assess vegetation and soil variability, and detect unusual conditions in a timely manner are therefore of high interest. Thus, innovative combinations and novel applications of component technologies are sought.

5. Performance Metrics

In keeping with current requirements by the Office of Management and Budget, projects will be reviewed against stated performance metrics. While metrics for each project will vary, there are a number of common concepts that are important for proposers

to consider in responding to this solicitation. Proposers should develop metrics in four areas:

5.1 Input

Input includes all those elements needed to complete and carry out the project, including human and physical capital and raw materials required for the research and applications process. Proposals should clearly describe all costs associated with the proposed effort and, at a minimum, will include:

- an overall budget;
- number and types of researchers/teams;
- data required;
- hardware and software and any specific maintenance and licenses required;
- travel and field work; office supplies and expenses;
- overhead and or fees; and,
- use of other assets e.g., aircraft, ancillary data/information.

It is important to also document the amount and type of cost sharing associated with the proposed effort, in-kind services, time and materials, or other.

5.2 Output

Output includes immediate observable products of the research and application activity and describes the efficiency resulting from the use of the resources. This includes data sets obtained, models developed, papers published, number of presentations made, number of graduate students supported, dissertations written, etc. More specifically, proposers should describe the level of use and the value of ESE data/information (i.e., sensor products, science results, algorithms, etc.) to the overall effort. Proposers should also discuss the degree of integration (and or fusion), and the contribution to the effort of other space-based, aircraft and ancillary data sets either public or private. Proposers must describe how the results of their applications research efforts will be distributed to or be made known to the broadest possible portion of the potential user community.

5.3 Outcome

The outcome of the research describes longer-term results to which the program contributes. It includes understanding gained, applications demonstrated, programmatic decisions enabled. NASA is interested here in things such as:

- Does the proposed effort develop and or demonstrate a new, original or improved application?
- Does the proposed applications research effort take a science result and push the applications science envelope forward?

Examples might include: can improved satellite estimates of evapotranspiration (ET) be operationally employed to improve the efficiency of irrigation applications; can satellite derived forest stand inventory estimates be upgraded by the fusion of MODIS, ETM+ and commercially available 1 meter class data; and can range readiness predictions be improved through the use of ESE biomass prediction procedures?

5.4 Impact

Impact describes the total consequences of the program, including intended benefits and unintended positive results. More simply, it describes the utility of and benefit to the customers. How is it useful, particularly with respect to better decision-making, lowering expenditures, or improving profits? Most important, the impact issue answers the question: “So what?”

Impact includes things such as new knowledge shared, costs saved, new applications done that were not possible before, and how did or would the results impact the public good or expanded commercialization. Proposers must identify and communicate the market for and the economic benefits of the proposed effort. Proposers must also describe the need of the end user community and demonstrate how these users will be involved in the proposed effort, as well as their readiness for the products of the proposed applications research effort. Proposers must also communicate that there is “a greater user community” beyond groups involved in the project. That is, the proposer must clearly demonstrate that the results of the proposed applications research effort are not unique to a specific site or user but have applicability in a significant portion of an important user community. With respect to the “so what” for the user community, NASA is interested in how proposers will evaluate the impact of their research in terms of: results adoption by the whole or a segment of the user community (e.g. value-added companies, end user companies and or agencies); and, increased benefits, cost-savings and or capability/capacity to accomplish something that was not possible or feasible previously.

6. Reporting and Team Activities

NASA will form an ESARP Team composed of investigators selected through this NRA, as well as possibly other selected investigators from other peer reviewed programs within ESE, and other individuals from other federal, state, and/or local agencies and commercial enterprises that NASA believes can significantly contribute to ESARP’s programmatic objectives. The ESARP team will meet at least once each year, to review progress, report results, and advise ESE on new applications that show promise. In addition, the ESARP team will advise NASA on a variety of topics related to hastening the movement of NASA science technology and results into the operational and commercial arenas, including the development of new applications initiatives.

One specific charge to the ESARP team will be to develop a series of reports and assessments of the applications potential of NASA ESE data and information products, based on the experiences of each project. These summary reports will cover broad ESE objectives, including reviews of sensors which have proven or promise potential economic benefits to end users in specific areas of application. These reports will go beyond the reports that are expected to be generated for publication in the reviewed journal literature and will be targeted at high-level decision-makers and the public. The reports will tie ESARP achievements, potential program thrusts, and benefits to the remote sensing community as a whole.

7. Outreach

In addition to conventional print media, each research project will seek to reach a broader audience through other forms of media. Projects are expected to develop World Wide Web sites that describe their projects, and provide linkages to the ESE home page. They will also be encouraged to find outlets in other media (e.g., popular press, broadcast) to reach an even broader audience. It is expected that these outreach efforts will be coordinated by the ESARP team.

8. Guidance for Proposers

8.1 Evaluation Criteria

The following criteria will be used to evaluate proposals. Criteria 8.1.1 and 8.1.3 have equal weight and are more heavily weighted than criterion 8.1.2.

8.1.1 Technical approach

- The suitability of the proposed application (or set of applications) in terms of addressing significant issues and the probability of meeting stated objectives;
- The feasibility, soundness, logic and practicality of the proposed technical methods and concepts for achieving successful applications research;
- The clear identification of user needs and benefits from proposed products or services for the target user(s);
- The centrality of remote sensing and its attending technologies to achieving project objectives.

8.1.2 Cost effectiveness and benefits

- The potential value of the products and services (i.e., cost/benefit and regional applications benefits) to the targeted user community.

8.1.3 Management and experience

- The feasibility of the management approach along with the methods and concepts demonstrated by the proposal;
- The feasibility of the outreach plan and the soundness of the philosophy and methods by which it is effected;
- The demonstrated competence and relevant experience of the proposers as an indication of their ability to carry the proposed activity to a successful conclusion (the proposal must show the qualifications and capabilities of the Project Lead, management team, and key personnel relevant to the success of the proposed activity);
- The adequacy of the facilities and equipment to support the proposed activity;
- The adequacy of metrics and other statistics to be collected that will measure the success of the activity.

8.2 Schedule

Letters of Intent Due	July 27, 1998
Proposals Due	September 8, 1998
Selections Announced	February, 1999
Agreements Awarded	April, 1999

8.3 Eligibility

Investigators at scientific research, educational institutions, public/government (NASA centers included) and private agencies or organizations and commercial entities in the U.S. are eligible to apply for funding under this NRA. Investigators from similar institutions, agencies, organizations, and/or entities in other countries are eligible to apply for participation in a research proposal under this NRA on a no-exchange-of-funds basis. NASA specifically encourages researchers in other U.S. government agencies with remote sensing applications responsibilities to participate as members in no-cost or low-cost applications, but notes that civil servants may not request salary reimbursement. Civil servants in other U.S. government research laboratories are eligible to apply, but also may not request salary reimbursement.

8.4 Proposal Submission and Review

Proposals may be up to fifteen pages of text, single-spaced, 12-pt. type, including references. A reasonable number of figures and tables (no more than 5 pages) may be appended. Not included in this total are: cover page, table of contents, facilities and equipment, curriculum vitae (optional for Co-I's), current and pending support, letters of Co-I and collaborator commitment, and detailed budget information. Full proposals will be mailed to at least three independent peer reviewers who will be asked to evaluate them on the basis of their relevance to NASA's objectives, intrinsic merit, stated performance metrics and cost. Evaluation criteria for the proposals are provided in Section 8.1.

Proposals must contain a *Budget Summary* (form given in Appendix E) for each year of the proposed effort filled out in accordance with the *Instructions for Budget Summary* on the page that follows it. Special attention is directed to the discussion of item 2.c. *Equipment* on the *Instructions* sheet regarding the proposed purchase of personal computers and/or commercially available software, both of which are considered to be "general purpose equipment." In the event that a proposal is selected for award, failure to adequately address the provisions of the instructions for item 2.c will require that the NASA awards office contact the proposing institution for the required information, which may delay the award until the purchase is either justified as a direct charge for general purpose equipment or is rebudgeted as an indirect expense.

Any negotiations prior to final decisions will occur only after the mail reviews of proposals have been received. Final decisions will be made promptly and investigators will be notified through both electronic mail and surface mail. All proposers will receive anonymous copies of review comments from the mail reviewers.

Additional information is provided in Appendices A-F of this Announcement.

Appendix A contains the basic guidance needed for proposal preparation in response to this announcement. Note that when requirements listed in Sections 1 through 5 in the front part

of this NRA overlap with the similar requirements in Appendix A, the requirements in Sections 1 through 5 take precedence. Appendix B provides guidance for international participation. Appendix C provides the list of required declarations and the proposal cover sheet. Appendix D provides the notice of intent to propose. The budget form and its instructions are in Appendix E. Appendix F contains material on NASA aircraft, EOS sensors, and data systems availability.

Note that URL addresses for accessing home pages with relevant information to this NRA are provided within this document. If electronic access is not available to the prospective proposers, a hard copy of relevant reference(s) can be requested through the points of contact identified below.

Identifier: NRA 98-OES-09

Submit Proposals to:

Remote Sensing Applications Research in Agriculture, Forestry, and Range Resources
Management
Code Y
400 Virginia Avenue, SW, Suite 700
Washington, DC 20024
202-554-2775

Copies required: 10

Selecting Official: Director,
Applications Research and Outreach Division

To obtain additional general information:

Mr. Alexander J. Tuyahov
Manager, Earth Science Applications Research Program (ESARP)
NASA HQ
Code YO
300 E St., SW
Washington, DC 20456
Phone: 202-358-0250
Fax: 202-358-3098
email: atuyahov@hq.nasa.gov

or

Dr. Charles Hutchison
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Code YO
300 E St., SW
Washington, DC 20456
Phone: 202-358-0762
Fax: 202-358-3098
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Mr. Douglas R. Kahle
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300 E St., SW
Washington, DC 20456
Phone: 202-358-0745
Fax: 202-358-2769
email: dkahle@hq.nasa.gov

Your interest and cooperation in participating in this opportunity are appreciated.

Ghassem R. Asrar
Associate Administrator for
Earth Science

Enclosures:

Appendix A, "Instructions for Responding to NASA Research Announcements"
Appendix B, "Guidelines for International Proposals"
Appendix C, "Required Declarations and proposal Cover Sheet"
Appendix D, "Notice of Intent to Propose"
Appendix E, "Budget Summary"
Appendix F, "Supporting Facilities"

APPENDIX A

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS

Part 1852.235-72

NASA Federal Acquisition Regulations (FAR) Supplement (NFS)
Version 89.90, Effective January 1997.

Accessible

<<http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm>>,
open 'Part 1852.228 to 1852.241' from menu.

(a). General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a preaward synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRA's contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRA's.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument. Contracts resulting from NRA's are subject to the Federal Acquisition Regulation (FAR) and the NASA FAR Supplement (NFS). Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRA's; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

(b). NRA-Specific Items. Several proposal submission items appear in the NRA itself: the unique NRA identifier, when to submit proposals, where to send proposals, number of copies required, and sources for more information. Items included in these instructions may be supplemented by the NRA.

(c). Proposal Content. The following information is needed to permit consideration in an objective manner. NRA's will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) *Transmittal Letter or Prefatory Material.*

(i) The legal name and address of the organization and specific division or campus identification, if part of a larger organization;

(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(vi) Identification of the NRA, by number and title, to which the proposal is responding;

(vii) Dollar amount requested, desired starting date, and duration of project;

(viii) Date of submission; and

(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) *Restriction on Use and Disclosure of Proposal Information*. Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following Notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the Notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the Notice.

Notice**Restriction on Use and Disclosure of Proposal Information**

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal, the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) *Abstract.* Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) *Project Description.*

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance, relation to the present state of knowledge, and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) *Management Approach.* For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) *Personnel.* The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications, and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic

attainment. Any special industry-university cooperative arrangements should be described.

(7) *Facilities and Equipment.*

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non research purposes should be explained.

(8) *Proposed Costs.*

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages, fringe benefits, equipment, expendable materials and supplies, services, domestic and foreign travel, ADP expenses, publication or page charges, consultants, subcontracts, other miscellaneous identifiable direct costs, and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired, purpose and estimated number and lengths of trips planned, basis for indirect cost computation (including date of most recent negotiation and cognizant agency), and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(9) *Security.* Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) *Current Support.* For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) *Special Matters.*

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

(d). Renewal Proposals

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

(e). Length. Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

(f). Joint Proposals.

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

(g). Late Proposals. A proposal or modification received after the date or dates specified in an NRA may be considered if doing so is in the best interests of the Government.

(h). Withdrawal. Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

(i). Evaluation Factors

(1) Unless otherwise specified in the NRA (see Section 8.1 in NRA), the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

(j). Evaluation Techniques. Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases, proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

(k). Selection for Award.

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

(1). Cancellation of NRA. NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.

APPENDIX B

GUIDELINES FOR FOREIGN PARTICIPATION

NASA accepts proposals containing non-U.S. participation as part of a potential research proposal in response to this NRA. Potential non-U.S. participants will not be funded through this NRA, and must be endorsed by the respective government agency or funding/sponsoring institution in the country from which the non-U.S. participant is proposing. Such endorsement should indicate the following points: (1) The proposal merits careful consideration by NASA; and (2) If the proposal is selected, sufficient funds will be made available by the sponsoring foreign agency to undertake the activity as proposed.

Such proposals, along with the requested number of copies and Letter of Endorsement must be forwarded to NASA in time to arrive before the deadline established for this NRA. In addition, one copy of each of these documents should be sent to:

NASA Headquarters
Office of External Relations
Earth Science Division, Code IY
Washington, DC 20546
USA

Any materials sent by courier or express mail should include the street address 300 E Street, S. W., and substitute 20024 for the indicated ZIP code.

All proposals must be typewritten in English. U.S. Proposals that include non-U.S. participation, must follow all other guidelines and requirements described in this NRA.

Successful and unsuccessful proposers will be contacted directly by the NASA Program Office coordinating the NRA. Copies of these letters will be sent to the sponsoring government agency.

APPENDIX C, Part 1

Proposal Cover Sheet

NASA Research Announcement 98-OES-09

Proposal No. _____ (Leave Blank for NASA Use)

Title: _____

Principal Investigator:: _____

Department: _____

Institution: _____

Street/PO Box: _____

City: _____ State: _____ Zip: _____

Country: _____ E-mail: _____

Telephone: _____ Fax: _____

Co-Investigators:

Name	Institution	Telephone
_____	_____	_____
_____	_____	_____
_____	_____	_____

Budget:

1st Year: _____ 2nd Year: _____ 3rd Year: _____ Total: _____

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in this *Cover Sheet/Proposal Summary* in response to NRA 98-OES-09, the Authorizing Official of the proposing institution (or the individual proposer if there is no proposing institution) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in the two Certifications contained in this NRA [namely, (i) *Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs, and* (ii) *Certifications, Disclosures, And Assurances Regarding Lobbying, Debarment & Suspension*].

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

Title of Authorizing Institutional Official: _____

Signature: _____ Date: _____

Name of Proposing Institution: _____

Telephone: _____ E-mail: _____ Facsimile: _____

APPENDIX C, Part 2

Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

The (*Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant "*) hereby agrees that it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1962 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and hereby give assurance that it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

This assurance is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognized and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

NASA FORM 1206

APPENDIX C, Part 3

CERTIFICATIONS, DISCLOSURES, AND ASSURANCES REGARDING LOBBYING, AND DEBARMENT & SUSPENSION

1. LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 14 CFR Part 1271, as defined at 14 CFR Subparts 1271.110 and 1260.117, with each submission that initiates agency consideration of such applicant for award of a Federal contract, grant, or cooperative agreement exceeding \$ 100,000, the applicant must **certify** that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit a Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

2. GOVERNMENTWIDE DEBARMENT AND SUSPENSION

As required by Executive Order 12549, and implemented at 14 CFR 1260.510, for prospective participants in primary covered transactions, as defined at 14 CFR Subparts 1265.510 and 1260.117—

(1) The prospective primary participant **certifies** to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any Federal department or agency.

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

APPENDIX D

Letter of Intent

All prospective proposers are strongly encouraged to submit a letter of intent in response to this announcement. This will allow us to alert a peer review staff to adequately cover the proposal review process. This letter of intent is available electronically via the Internet at URL: <http://www.mtpe.hq.nasa.gov/LOI/form.html>. The URL for the Co-Investigator information is: <http://www.mtpe.hq.nasa.gov/LOI/coi.html>. We urge you to use these electronic letter of intent forms unless you do not have access to the Internet. In that case, we will accept a FAX copy sent to 202-554-3024 with the following information:

- PI and CoI names and addresses, (including Zip + 4);
- Title of proposal;
- Telephone number;
- Fax number;
- Email address; and
- A brief summary of what you plan to propose (Please limit this to no more than 3000 characters).

APPENDIX E:

BUDGET SUMMARY

For period from _____ to _____

- Provide a complete Budget Summary for year one and separate estimated for each subsequent year.
- Enter the proposed estimated costs in Column A (Columns B & C for NASA use only).
- Provide as attachments detailed computations of all estimates in each cost category with narratives as required to fully explain each proposed cost. See *Instructions For Budget Summary* on following page for details.

	A	NASA USE ONLY	
		B	C
1. <u>Direct Labor</u> (salaries, wages, and fringe benefits)	_____	_____	_____
2. <u>Other Direct Costs</u> :			
a. Subcontracts	_____	_____	_____
b. Consultants	_____	_____	_____
c. Equipment	_____	_____	_____
d. Supplies	_____	_____	_____
e. Travel	_____	_____	_____
f. Other	_____	_____	_____
3. <u>Facilities and Administrative Costs</u>	_____	_____	_____
4. <u>Other Applicable Costs</u> :	_____	_____	_____
5. <u>SUBTOTAL--Estimated Costs</u>	_____	_____	_____
6. <u>Less Proposed Cost Sharing</u> (if any)	_____	_____	_____
7. <u>Carryover Funds</u> (if any)			
a. Anticipated amount : _____			
b. Amount used to reduce budget _____			
8. <u>Total Estimated Costs</u>	_____	_____	XXXXXXX
9. APPROVED BUDGET	XXXXXXX	XXXXXXX	_____

INSTRUCTIONS FOR BUDGET SUMMARY

1. **Direct Labor (salaries, wages, and fringe benefits):** Attachments should list the number and titles of personnel, amounts of time to be devoted to the grant, and rates of pay.
2. **Other Direct Costs:**
 - a. **Subcontracts:** Attachments should describe the work to be subcontracted, estimated amount, recipient (if known), and the reason for subcontracting.
 - b. **Consultants:** Identify consultants to be used, why they are necessary, the time they will spend on the project, and rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).
 - c. **Equipment:** List separately. Explain the need for items costing more than \$5,000. Describe basis for estimated cost. General purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested to be made as a direct charge under this award must include the equipment description, how it will be used in the conduct of the basic research proposed and why it cannot be purchased with indirect funds.
 - d. **Supplies:** Provide general categories of needed supplies, the method of acquisition, and the estimated cost.
 - e. **Travel:** Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.
 - f. **Other:** Enter the total of direct costs not covered by 2a through 2e. Attach an itemized list explaining the need for each item and the basis for the estimate.
3. **Facilities and Administrative (F&A) Costs:** Identify F&A cost rate(s) and base(s) as approved by the cognizant Federal agency, including the effective period of the rate. Provide the name, address, and telephone number of the Federal agency official having cognizance. If unapproved rates are used, explain why, and include the computational basis for the indirect expense pool and corresponding allocation base for each rate.
4. **Other Applicable Costs:** Enter total explaining the need for each item.
5. **Subtotal-Estimated Costs:** Enter the sum of items 1 through 4.
6. **Less Proposed Cost Sharing (if any):** Enter any amount proposed. If cost sharing is based on specific cost items, identify each item and amount in an attachment.
7. **Carryover Funds (if any):** Enter the dollar amount of any funds expected to be available for carryover from the prior budget period. Identify how the funds will be used if they are not used to reduce the budget. NASA officials will decide whether to use all or part of the anticipated carryover to reduce the budget (not applicable to 2nd-year and subsequent-year budgets submitted for award of a multiple year award).
8. **Total Estimated Costs:** Enter the total after subtracting items 6 and 7b from item 5.

APPENDIX F: SUPPORTING FACILITIES

1. AIRBORNE INSTRUMENTS

The National Aeronautics and Space Administration maintains a variety of aircraft and sensor systems dedicated to the support of remote sensing research. Two Lockheed ER-2 (U-2S,) a DC-8, and several U.S. Dept. of Energy aircraft provide multi-level platforms for both NASA and investigator-owned sensors. Data are collected for the atmospheric, land, and ocean processes aspects of the NASA Earth Science program, as well as for universities and other government agencies. Several of these systems are being used to validate algorithms for the NASA Earth Observing System.

The NASA aircraft, located at Dryden Flight Research Center, are used as test-beds for advanced sensor design and satellite simulation, as well as to support scientific and operational data collection campaigns. Various systems are in use and under development, including eight different multispectral imaging devices, a SAR system, and a suite of large-format mapping cameras. The aircraft are equipped with GPS locational systems, and continuously record platform attitude information. All instruments are spectrally, spatially, and radiometrically calibrated on a routine basis.

The systems described here are facility NASA sensors, and are generally available to the science community. They reside at Ames Research Center and the Jet Propulsion Laboratory. There are numerous other sensors that fly on these aircraft that are owned by individual investigators, and are not within the scope of this document.

To request flights of the NASA aircraft and or use of NASA instrumentation, a Flight Request form is required. These forms are available from the Ames Research Center, ATTN.: Aircraft Programs, MS 211-17, Moffett Field CA, 94035-1000, phone 415-604-6099 (-1750 fax). For more information on the airborne programs, connect to WWW sites: <http://airsci-www.arc.nasa.gov/> or <http://www.wff.nasa.gov/~web/msn.html>.

AVIRIS (Airborne Visible and Infrared Imaging Spectrometer)

The AVIRIS is the second in a series of imaging spectrometer instruments developed at the Jet Propulsion Laboratory (JPL) for earth remote sensing. This instrument uses scanning optics and four spectrometers to image a 614 pixel swath simultaneously in 224 contiguous spectral bands.

AVIRIS parameters are as follows:

IFOV: 1 mrad
Ground Resolution: 66 feet (20 meters) at 65,000 feet
Total Scan Angle: 30 degrees
Swath Width: 5.7 nmi (10.6 km) at 65,000 feet
Digitization: 12-bits

<u>Spectrometer</u>	<u>Wavelength</u>	<u>#Bands</u>	<u>Bandwidth</u>
1	0.41 - 0.70 μm	31	9.4 nm
2	0.68 - 1.27 μm	63	9.4 nm
3	1.25 - 1.86 μm	63	9.7 nm
4	1.84 - 2.45 μm	63	9.7 nm

Notes: This instrument is flown on the ER-2 aircraft. All data collection missions are coordinated through JPL.

(See the AVIRIS homepage at <http://makalu.jpl.nasa.gov/aviris.html>)

MODIS Airborne Simulator

The MODIS Airborne Simulator (MAS) is a multispectral scanner configured to approximate the Moderate-Resolution Imaging Spectrometer (MODIS), an instrument to be orbited on the NASA EOS-AM1 platform. MODIS is designed to measure terrestrial and atmospheric processes. The MAS was a joint project of Daedalus Enterprises, Berkeley Camera Engineering, and Ames Research Center. The MODIS Airborne Simulator records fifty spectral bands, configured as follows:

Spectral Channel	Band center (μm)	Bandwidth (μm)	Spectral Range
1	0.4649	0.0397	0.4451-0.4848
2	0.5494	0.0417	0.5285-0.5703
3	0.6550	0.0511	0.6294-0.6805
4	0.7024	0.0415	0.6816-0.7231
5	0.7431	0.0420	0.7221-0.7641
6	0.8248	0.0427	0.8034-0.8461
7	0.8667	0.0414	0.8460-0.8874
8	0.9072	0.0409	0.8867-0.9276
9	0.9476	0.0397	0.9277-0.9674
10	1.6422	0.0519	1.6163-1.6682
11	1.6975	0.0505	1.6722-1.7228
12	1.7499	0.0506	1.7245-1.7752
13	1.8014	0.0491	1.7768-1.8259
14	1.8548	0.0489	1.8303-1.8792
15	1.9044	0.0487	1.8801-1.9288
16	1.9553	0.0483	1.9312-1.9794
17	2.0048	0.0487	1.9804-2.0291

Spectral Channel	Band center (μm)	Bandwidth (μm)	Spectral Range
26	3.1192	0.1616	3.0384-3.2000
27	3.2809	0.1486	3.2066-3.3552
28	3.4330	0.1617	3.3521-3.5138
29	3.5940	0.1539	3.5170-3.6709
30	3.7449	0.1449	3.6724-3.8174
31	3.9069	0.1602	3.8267-3.9870
32	4.0707	0.1554	3.9929-4.1484
33	4.1699	0.0669	4.1365-4.2034
34	4.4029	0.1255	4.3401-4.4656
35	4.5404	0.1512	4.4648-4.6160
36	4.6979	0.1591	4.6184-4.7775
37	4.8536	0.1516	4.7778-4.9294
38	5.0033	0.1468	4.9298-5.0767
39	5.1588	0.1400	5.0888-5.2288
40	5.3075	0.1327	5.2412-5.3738
41	5.3977	0.0755	5.3590-5.4365
42	8.5366	0.3950	8.3391-8.7341

18	2.0551	0.0484	2.0309-2.0793
19	2.1037	0.0486	2.0794-2.1280
20	2.1532	0.0483	2.1291-2.1774
21	2.2019	0.0481	2.1779-2.2259
22	2.2522	0.0486	2.2278-2.2675
23	2.3021	0.0487	2.2777-2.3265
24	2.3512	0.0476	2.3274-2.3750
25	2.4005	0.0483	2.3764-2.4246

43	9.7224	0.5365	9.4541-9.9906
44	10.5071	0.4579	10.278-10.736
45	11.0119	0.4710	10.776-11.247
46	11.9863	0.4196	11.776-12.196
47	12.9013	0.3763	12.713-13.089
48	13.2702	0.4584	13.041-13.500
49	13.8075	0.5347	13.540-14.075
50	14.2395	0.3775	14.051-14.428

Sensor/Aircraft Parameters:

Spectral Bands: 50 (16-bit resolution)
 IFOV: 2.5 mrad
 Ground Resolution: 163 feet (50 meters at 65,000 feet)
 Swath Width: 19.9 nmi (36 km)
 Total Scan Angle: 85.92 degrees
 Pixels/Scan Line: 716
 Scan Rate: 6.25 Hz
 Ground Speed: 400 kts (206 m/second)
 Roll Correction: Plus or minus 3.5 degrees (approx.)

(See the homepage at <http://ltpwww.gsfc.nasa.gov/MODIS/MAS/Home.html>)

MASTER (MODIS/ASTER Airborne Simulator)

The MASTER is similar to the MAS, with the thermal bands modified to more closely match the NASA EOS ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) satellite instrument, which is scheduled for launch in 1998. It is intended primarily to study geologic and other Earth surface properties. Flying on both high and low altitude aircraft, the MASTER will be operational in early 1998. Its fifty spectral bands are configured as follows:

Spectral Channel	Band center (μm)	Bandwidth (μm)	Spectral Range
1	0.460	0.04	0.440-0.480
2	0.500	0.04	0.480-0.520
3	0.540	0.04	0.520-0.560
4	0.580	0.04	0.560-0.600
5	0.660	0.06	0.630-0.690
6	0.710	0.04	0.690-0.730
7	0.750	0.04	0.730-0.770

Spectral Channel	Band center (μm)	Bandwidth (μm)	Spectral Range
26	3.150	0.15	3.075-3.225
27	3.300	0.15	3.225-3.375
28	3.3450	0.15	3.375-3.525
29	3.600	0.15	3.525-3.675
30	3.750	0.15	3.675-3.825
31	3.900	0.15	3.825-3.975
32	4.050	0.15	3.975-4.125

8	0.800	0.04	0.780-0.820
9	0.865	0.04	0.845-0.885
10	0.905	0.04	0.885-0.925
11	0.945	0.04	0.925-0.965
12	1.625	0.05	1.600-1.650
13	1.675	0.05	1.650-1.700
14	1.725	0.05	1.700-1.750
15	1.775	0.05	1.750-1.800
16	1.825	0.05	1.800-1.850
17	1.875	0.05	1.850-1.900
18	1.925	0.05	1.900-1.950
19	1.975	0.05	1.950-2.000
20	2.075	0.05	2.050-2.100
21	2.160	0.05	2.135-2.185
22	2.210	0.05	2.185-2.235
23	2.260	0.05	2.235-2.285
24	2.3295	0.065	2.297-2.362
25	2.3945	0.065	2.362-2.427

33	4.200	0.15	4.125-4.275
34	4.575	0.6	4.275-4.875
35	4.500	0.15	4.425-4.575
36	4.650	0.15	4.575-4.725
37	4.800	0.15	4.725-4.875
38	4.950	0.15	4.875-5.025
39	5.100	0.15	5.025-5.175
40	5.250	0.15	5.175-5.325
41	7.900	0.4	7.70-8.10
42	8.300	0.4	8.10-8.50
43	8.700	0.4	8.50-8.90
44	9.100	0.4	8.90-9.30
45	9.700	0.4	9.50-9.90
46	10.100	0.4	9.90-10.30
47	10.625	0.65	10.30-10.95
48	11.300	0.7	10.95-11.65
49	12.050	0.5	11.80-12.30
50	12.750	0.5	12.50-13.00

Sensor/Aircraft Parameters:

Spectral Bands: 50 (16-bit resolution)
 IFOV: 2.5 mrad
 Ground Resolution: 12-50 meters (variable w/ altitude)
 Total FOV: 85.92 degrees
 Pixels/Scanline: 716
 Scan Rate: 6.25 - 25 Hz

(See the homepage at asterweb.jpl.nasa.gov)

AirMISR (Airborne Multi-angle Imaging SpectroRadiometer)

This is an airborne instrument for obtaining multi-angle imagery similar to that of the satellite-borne MISR instrument, which is designed to contribute to studies of the Earth's ecology and climate. AirMISR flies on the NASA-owned ER-2 aircraft. It was built for NASA by the Jet Propulsion Laboratory in Pasadena, California.

(See the homepage at <http://www-misr.jpl.nasa.gov/armain.html>)

AIRSAR (Airborne Synthetic Aperture Radar)

This is an experimental system managed by the NASA Jet Propulsion Laboratory (JPL,) that flies on the DC-8 aircraft. It simultaneously acquires data in the L, P, and C-Bands in multiple polarizations.

The system was designed in support of the Space Shuttle Imaging Radar-C (SIR-C) program, but is widely used in the SAR remote sensing research community.

(See the homepage at <http://southport.jpl.nasa.gov/airsardesc.html>)

TMS (Thematic Mapper Simulator)

This is a Daedalus AADS-1268 scanner that flies on the ER-2 aircraft and simulates the LANDSAT TM instrument, with slightly higher spatial resolution, and several extra bands.

<u>Band</u>	<u>Wavelength μm</u>
1	0.42- 0.45
2 (TM1)	0.45- 0.52
3 (TM2)	0.52- 0.60
4	0.60- 0.62
5 (TM3)	0.63- 0.69
6	0.69- 0.75
7 (TM4)	0.76- 0.90
8	0.91- 1.05
9 (TM5)	1.55- 1.75
10 (TM7)	2.08- 2.35
11 (TM6) High Gain	8.5- 14.0
12 (TM6) Low Gain	8.5- 14.0

Spatial Resolution: 25 meters (all bands) from 19.8 km (65,000 ft.)
Total Field of View: 42.5 degrees
IFOV: 1.25 mrad

Notes: All bands are 8-bit digitization; onboard blackbody sources are carried for thermal calibration. The system is scheduled to be upgraded to 16-bit resolution in late 1998.

(See the homepage at <http://asapdata.arc.nasa.gov/Sensors.htm>)

AOCI (Airborne Ocean Color Imager)

The AOCI is a high altitude multispectral scanner built by Daedalus Enterprises, designed for oceanographic remote sensing. It provides 10-bit digitization of eight bands in the visible/near-infrared region of the spectrum, plus two 8-bit bands in the near and thermal infrared. The bandwidths are as follows:

<u>Channel</u>	<u>Wavelength, μm</u>
1	0.436 - 0.455
2	0.481 - 0.501
3	0.511 - 0.531
4	0.554 - 0.575
5	0.610 - 0.631
6	0.655 - 0.676
7	0.741 - 0.800
8	0.831 - 0.897
9	0.989 - 1.054
10	8.423 - 12.279

Spatial Resolution: 50 Meters from 19.8 km (65,000 ft.)
Total Field of View: 85 degrees
IFOV: 2.5 mrad

Note: The system is scheduled to be upgraded to 16-bit resolution in late 1998.

(See the homepage at <http://asapdata.arc.nasa.gov/Sensors.htm>)

MAMS (Multispectral Atmospheric Mapping Sensor)

The MAMS is a modified Daedalus Scanner flown aboard the ER-2 aircraft. It is designed to study weather related phenomena including storm system structure, cloud-top temperatures, and upper atmospheric water vapor. The scanner retains the eight silicon-detector channels in the visible/near-infrared region found on the Daedalus Thematic Mapper Simulator, with the addition of four channels in the infrared relating to specific atmospheric features. The spectral bands are as follows:

<u>Channel</u>	<u>Wavelength, μm</u>
1	(LSBs for Channels 9-12)
2	0.45 - 0.52
3	0.52 - 0.60
4	0.57 - 0.67
5	0.60 - 0.73
6	0.65 - 0.83
7	0.72 - 0.99
8	0.83 - 1.05
9	3.55 - 3.93 (6.20- 6.90 optional)
10	3.55 - 3.93 (" " ")
11	10.3 - 12.1
12	12.5 - 12.8

Spatial Resolution: 50 or 100 meters from 19.8 km (65,000 ft.)

Total Field of View: 85.92 degrees

IFOV: 2.5 or 5.0 mrad (selectable)

Notes: Channels 9 - 12 are digitized to 10 bits; all others are 8-bit. Blackbody sources are carried for IR calibration. The system is scheduled to be upgraded to 16-bit resolution in late 1998.

(See the homepage at <http://www.ghcc.msfc.nasa.gov/irgrp/mams>)

Electro-Optic Camera

This is a three channel framing camera designed for the ER-2, consisting of three 2048 X 2048 element, cooled silicon arrays mounted on a prism behind a single lens. The channels cover the green, red, and near-IR portions of the spectrum; each channel can be further narrowed within its respective range with a removable narrow-band filter mounted on the dichroic prism face.

<u>Channel</u>	<u>Wavelength, μm</u>
1	.525 - .570
2	.620 - .700
3	.810 - .850

Total Field of View: 60 degrees

IFOV: 0.52 mrad

Digitization: 12 bits

(See the homepage at <http://asapdata.arc.nasa.gov/Sensors.htm>)

Aerial Camera Systems

The ER-2 can carry a variety of film camera systems. Several of these cameras are calibrated for precision photogrammetry, and the film may be used to generate digital orthophotos or high-resolution digital elevation models.

<u>Camera Type</u>	<u>Lens</u>	<u>Film Format</u>	<u>Ground Coverage</u>	<u>Nominal Resolution</u>	<u>Scale</u>
RC-10	6"/f4	9" X 9"	30 X 30km	3.0-8.0m	1:130,000
RC-10	12"/f4	9" X 9"	15 X 15km	1.5-4.0m	1:65,000
HR-732	24"/f8	9" X 18"	7.4 X 15km	0.6-3.0m	1:32,500
IRIS (Panoramic)	24"/f3.5	4.5" X 35"	3.7 X 40km (Nadir)	0.3-2.0m	1:32,500

Note: Spatial parameters are for the ER-2 at 19.8 km altitude; actual resolution is a function of target contrast. Missions are typically flown with 60% forward frame overlap for stereo coverage. RC-30 cameras are also available on the Dept. of Energy aircraft.

(See the homepage at <http://asapdata.arc.nasa.gov/Sensors.htm>)

STARLink

The Satellite Telemetry And Return Link (STARLink) system provides real-time, continuous relay of digital sensor data from the ER-2 aircraft via the NASA Tracking & Data Relay Satellite System (TDRSS.) It is currently configured to send 48 Mb/sec of data down to the ground station, and 400 Kb/sec simultaneously back up to the aircraft for sensor command and control. The system offers nearly global coverage, with the data being captured to disk arrays at Ames Research Center.

(See the homepage at <http://hawkeye.arc.nasa.gov>)

Other Imaging systems

The ER-2 and DC-8 aircraft are also equipped with video systems for tracking purposes, which are scheduled to be replaced by an HDTV devices.

Data Availability

All of the data collected by these systems is publicly available through U.S. Government agencies. Archives exist at the EROS Data Center of the U.S. Geological Survey in Sioux Falls, South Dakota; and within the NASA EOS-DAACs (Earth Observing System - Distributed Active Archive Centers.) Further information is available from the NASA Ames Research Center Aircraft Sensor Facility at (650) 604-6252.

2. SPACEBORNE INSTRUMENTS

NASA maintains an active program providing imagery and digital data of the earth from space, primarily through the Earth Observation System (EOS). The primary NASA instruments currently supplying land images of the earth are the Thematic Mapper on Landsat 5 and the AVHRR on the NOAA satellites. Between now and the end of the century, several platforms will be launched that will provide the NASA research community access to land observations. These include EOS AM-1, Landsat 7, and the EO-1. In addition, NASA will have access, through cooperative agreements and data purchases, to data from Radarsat and NOAA satellites. NASA may also purchase land observation data from non-US systems, e.g., SPOT, IRS, ADEOS, JERS, etc. to meet specific requirements of NASA sponsored research through agreements between NASA and space agencies of other governments or commercial operators.

The data available from NASA sponsored, earth orbiting, land observation instruments are described below, listed alphabetically by instrument name. All the platforms are polar orbiters. For more information on the instruments marked with an asterisk (*), see the "1995 MTPE EOS Reference Handbook" available from the EOS Project Science Office, Code 900, NASA Goddard Space Flight Center, Greenbelt, MD, 20771, the URL "<http://eospsso.gsfc.nasa.gov>" and/or the URL listed with the description of the instrument.

Advanced Land Imager (ALI)

Platform: EO-1

Launch Date: May 1999

The ALI is an experimental push broom spectrometer designed to test components for a possible Landsat 7 follow-on instrument. The spectral and spatial characteristics of the instrument are based on providing continuity with the ETM+ (see below) plus hyperspectral imaging. At present the operational availability is limited to one year due to funding.

Swath width = Pan 36 km; Multispectral 36 km; Hyperspectral 9.6 km.

Spectral/Spatial resolution = Pan (.5-.7 μm), 10 m; VNIR (8 channels .433-1.75 μm), 30 m; SWIR (1 channel 2.08-2.35 μm), 30 m; Hyperspectral (315 variable bandwidth samples .40-2.50 μm) 30 m.

For more information: <http://www710.gsfc.nasa.gov/~nmp-eo1/eo1.html>

Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)*

Platform: EOS AM-1

Launch Date: No earlier than December 1998

ASTER will provide high spatial resolution multispectral images of the earth's surface and clouds. The instrument is a multispectral imager that will record reflected and emitted radiation of the earth's surface. ASTER will have 4% absolute radiometric accuracy in the VNIR and SWIR bands, and absolute temperature accuracy of 3 K in the 200-240 K range, 2 K in the 240-270 K range, 1 K in the 270-340 K range and 2 K in the 340-370 K range in the thermal infrared bands.

Swath width = 60 km at nadir; swath center is pointable cross-track ± 106 km for SWIR and TIR, ± 314 km for VNIR

Spectral/Spatial resolution = VNIR (3 channels 0.5-0.9 μm), 15 m [stereo (0.7-0.9 μm), 15 m horizontal, 25 m vertical]; SWIR (6 channels 1.6-2.43 μm), 30 m; TIR (5 channels 8-12 μm), 90 m.

For more information: <http://asterweb.jpl.nasa.gov/>

Advanced Very High Resolution Radiometer (AVHRR)

Platform: NOAA series

Launch Date: On-going operational program

AVHRR is a five channel scanning radiometer that provides general, daily coverage of the earth.

Swath width = >2600 km

Spectral/Spatial resolution = VNIR (2 channels .58-1.10 μm), 1.1 km or 4.0 km; TIR (3 channels 3.55- 12.50 μm), 1.1 km or 4.0 km.

For more information: <http://www2.ncdc.noaa.gov/POD/>

Clouds and the Earth's Radiant Energy System (CERES)*

Platform

Launch Date

TRMM

November 1997

AM-1

No earlier than December 1998

PM-1

December 2000

The CERES is comprised of two broadband scanning radiometers: one cross-track mode, and one rotating plane (bi-axial scanning), except for the first CERES launched on TRMM. The TRMM model has only one radiometer, which is capable of being operated in either the cross-track or the bi-axial mode. CERES will measure both solar-reflected and Earth-emitted radiation from the top of the atmosphere to the surface. It will also determine cloud properties including the amount, height, thickness, particle size, and phase of clouds using simultaneous measurements by other instruments.

Spectral Bands (Channels)

0.3 to 12 microns

Swath

Limb to limb

Spatial Resolution

21 km at nadir

Mass

90 kg [two scanners]

Duty Cycle

100%

Power

scanners]

Power: 103 W (average), 106 W (peak) [two

Data Rate (Kbps)

20.00 (2 scanners)

For more information: <http://asd-www.larc.nasa.gov/ceres/ASDceres.html>

Enhanced Thematic Mapper Plus (ETM+)*

Platform: Landsat 7

Launch Date: No earlier than December 1998

The ETM+ instrument is a whiskbroom scanning radiometer that will provide synoptic, repetitive, multispectral, high resolution, digital images of all land surface of the earth. The instrument draws substantially on the heritage of the Landsat program, especially the Thematic Mapper instrument, but will offer improvements over previous instruments in the program, e.g., 5% absolute radiometric calibration, 15 m panchromatic band and 60 m thermal band. ETM+ imagery over the United States will be collected every 16 days and

made available to users within 24 hours of acquisition at the primary US ground station - EROS Data Center in Sioux Falls, South Dakota.

Swath width = 185 km

Spectral/Spatial resolution = Pan (.5-.9 μm), 15 m; VNIR (4 channels .45-.90 μm), 30 m; SWIR (2 channels 1.55-2.35 μm), 30 m; TIR (1 channel 10.42-12.50 μm), 60 m.

For more information: <http://geo.arc.nasa.gov/sge/landsat/17.html>

Multi-angle Imaging SpectroRadiometer (MISR)*

Platform: EOS AM-1

Launch Date: No earlier than December 1998

The MISR uses nine individual charge coupled device (CCD) based pushbroom cameras to observe the earth at nine discrete view angles - nadir and eight other symmetrical views.

Swath width = 360 km

Spectral/Spatial resolution = VNIR (4 channels .443-.865 μm), 275 m, 550 m, and 1.1 km.

For more information: <http://www-misr.jpl.nasa.gov/>

Moderate-resolution Imaging Spectroradiometer (MODIS)*

Platform: EOS AM-1

Launch Date: No earlier than December 1998

MODIS is an EOS facility instrument designed to measure biological and physical processes on a global basis every 1-2 days. The instrument will generate simultaneous, congruent observations of high-priority atmospheric, oceanic and land surface features.

Swath width = 2300 km at 110°

Spectral/Spatial resolution = 36 channels (21 at .4-3.0 μm ; 15 at 3.0-14.5 μm), 250 m, 500 m, 1 km.

For more information: <http://ltpwww.gsfc.nasa.gov/MODIS/MODIS.html>

RADARSAT

Platform: RADARSAT

Launch Date: Operational since 1995; RADARSAT-2: 2000

RADARSAT is a C-band synthetic aperture radar (SAR) system operated by Canada. The instrument provides images of any part of the earth's surface irrespective of clouds with a 1-10 day revisit interval dependent on the latitude and configuration of the sensor.

Swath width = 50-500 km

Spectral/Spatial resolution = Frequency/polarization = C/HH; 10-100 m.

For more information: <http://www.rsi.ca/>

Sea-viewing Wide Field-of-view Sensor (SeaWiFS)

Platform: SeaStar

Launch Date: August 1997

The SeaWiFS is a visible, near-infrared ocean color imager which provides quantitative data on global ocean bio-optical properties to the Earth science community. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications.

Sensor Characteristics

8 Bands: 412, 443, 490, 510, 555, 670, 765, 865 nm

SNR Range: 670 (865 nm) to 1156 (490 nm)

4 Bilinear Gains: 2 science, lunar, solar

Polarization Sensitivity: 0.25%, all bands

Coverage

Resolutions: 1 km (LAC), 4 km (GAC)

Swath: 2801 km (LAC), 1502 km (GAC)

Equatorial crossing time: local noon, descending

Sensor Tilts: -20, 0, +20 degrees (sun glint avoidance)

For more information: <http://seawifs.gsfc.nasa.gov/SEAWIFS.html>

Vegetation Canopy Lidar (VCL) Mission

Platform VCL Platform

Launch Date: February 2000

The principal goal of the VCL mission is the characterization of the three-dimensional structure of the Earth. The two main science objectives are: 1) landcover characterization for terrestrial ecosystem modeling, monitoring and prediction, and for climate modeling and prediction; and 2) global reference data set of topographic spot heights and transects. The Measurement Objectives are:

- Vegetation canopy top height < 1 m
- Vertical distribution of intercepted surfaces
- Ground surface topographic elevations < 1m
- Measurement transects are globally gridded to 2 km x 2 km data products
-

The VCL instrument consists of 3 - 5 Nd:YA diode-pumped pulsed lasers operating at: 290 pps (land), 10 mJ per pulse, 1064 nm wavelength with a projected lifetime of 2 years.

Swath width = 8 km

Resolution = 25 m (60 μ rad) footprint diameter at 400 km altitude

Track Spacing = 2 km

Elevation Accuracy < 1 m in low slope terrain

Vegetation Height Accuracy < 1 m limited by 100:1 pulse detection dynamic range and cal/val.

For more information: <http://essp.gsfc.nasa.gov/>

3. TELEMETRY AND CALIBRATION

STARLink - The Satellite Telemetry And Return Link (STARLink) system provides real-time, continuous relay of digital sensor data from the ER-2 aircraft via the NASA Tracking & Data Relay Satellite System (TDRSS). STARLink is currently configured to send 48 Mbps of data down to the ground station, and, simultaneously, to receive from the ground 400 Kbps of sensor command and control. The system offers nearly global coverage. Data received is captured on disk arrays at Ames Research Center.

Calibration Laboratory - The calibration laboratory for airborne sensors at Ames Research Center provides spectral and radiometric characterization of the instruments with traceability to the National Institute of Standards and Technology (NIST). Measurements can be performed in the spectral range of 350 nm to 15 microns. Laboratory assets include a monochromator, spectrometer, spectrophotometer, Fourier transform infrared spectrometer, a variety of "standard sources" and an environmental chamber.

4. DATA SYSTEMS

EOSDIS - The Earth Observing System Data and Information System (EOSDIS) is a comprehensive data and information system designed to perform a wide variety of functions in support of a national and international user community. EOSDIS will command and control satellites and instruments and will generate data sets from satellite and in situ observations. Services provided by EOSDIS include: data archive, distribution and management; information management; product generation; spacecraft command and control; and data capture and telemetry processing. NASA is implementing EOSDIS using a distributed, open systems architecture. This approach allows for the allocation of EOSDIS elements to various locations to benefit from different institutional capabilities and scientific expertise.

For an overview of EOSDIS see URL: http://spsosun.gsfc.nasa.gov/New_EOSDIS.html and for more information or to connect to Version 0 (V0) of the EOSDIS information management system (IMS) use the URL:

<http://harp.gsfc.nasa.gov/~imswww/pub/imswelcome/>.

Additional information on EOSDIS users can be found in the "Proceedings of the EOSDIS Potential User Group Development Effort Conference" on the

URL:<http://rsrunt.geog.ucsb.edu/eosdis.html>.

DAACs - The eight Distributed Active Archive Centers (DAACs) selected by NASA to carry out the processing, archiving, distributing the EOS and related data and providing user support are listed in the below table. The table includes a contact for the EOSDIS Earth Science Information management System (IMS), which provides a central interface for NASA's Earth Science data, and also contains a listing for NOAA's Satellite Active Archive (SAA), which contains NOAA's Polar-orbiting Operational Environmental Satellites (POES) real-time and historical satellite data.

<i>DAACs and other Data Contacts</i>	<i>ADDRESS</i>
EOSDIS IMS EOSDIS Information Management System http://harp.gsfc.nasa.gov/v0ims/ <i>The IMS provides search and order tools for accessing a wide variety of global Earth science data and information held at ten different EOSDIS and NOAA data centers.</i>	IMS Science and Operations Support 7701 Greenbelt Road, #400 Greenbelt, MD 20770 301-441-4197 voice 301-441-2392 fax Internet: closs@eos.nasa.gov
ASF Alaska SAR Facility (Alaska, USA) http://www.asf.alaska.edu/ <i>Sea Ice, Polar processes, SAR products</i>	ASF DAAC User Services Alaska SAR Facility University of Alaska PO Box 757320 Fairbanks, AK 99775-7320 907-474-6166 voice 907-474-5195 fax Internet: asf@eos.nasa.gov
EDC EROS Data Center (South Dakota, USA) http://edcwww.cr.usgs.gov/landdaac/landdaac.html <i>Land processes Imagery</i>	EDC DAAC User Services U.S. Geological Survey EROS Data Center Sioux Falls, SD 57198 605-594-6116 voice 605-594-6963 fax Internet: edc@eos.nasa.gov
GSFC Goddard Space Flight Center (Maryland, USA) http://daac.gsfc.nasa.gov/DAAC_DOCS/gdaac_home.html <i>Upper Atmosphere, Global Biosphere, Atmospheric Dynamics, Geophysics</i>	User Services Office, Code 902.2 Distributed Active Archive Center Goddard Space Flight Center Greenbelt, MD 20771 301-614-5224 voice 301-614-5268 fax Internet: gsfc@eos.nasa.gov
JPL Jet Propulsion Lab (California, USA) http://podaac-www.jpl.nasa.gov/ <i>Physical Oceanography</i>	JPL Physical Oceanography DAAC User Services NASA/Jet Propulsion Laboratory MS 300-320 4800 Oak Grove Drive Pasadena, CA 91109 818-354-9890 voice 818-393-2718 fax Internet: jpl@eos.nasa.gov
LaRC Langley Research Center (Virginia, USA) http://eosweb.larc.nasa.gov/ <i>Radiation Budget, Tropospheric Chemistry, Clouds, Aerosols</i>	Langley DAAC User Services NASA Langley Research Center Mail Stop 157D Hampton, VA 23681-0001 757-864-8656 voice 757-864-8807 fax Internet: larc@eos.nasa.gov
NSIDC National Snow and Ice Data Center (Colorado, USA) http://www-nsidc.colorado.edu/NASA/GUIDE/ <i>Snow and Ice, Cryosphere and Climate</i>	NSIDC DAAC User Services National Snow and Ice Data Center CIRES, Campus Box 449 University of Colorado Boulder, CO 80309-0449

	303-492-6199 voice 303-492-2468 fax Internet: nsidc@eos.nasa.gov
ORNL Oak Ridge National Lab (Tennessee, USA) http://www-eosdis.ornl.gov/ <i>Biogeochemical Dynamics</i>	ORNL DAAC User Services Office Oak Ridge National Laboratory PO Box 2008, Mail Stop 6407 Oak Ridge, TN 37831-6407 423-241-3952 voice 423-574-4665 fax Internet: ornl@eos.nasa.gov
SEDAC / CIESIN Socioeconomic Data and Applications Center Consortium for International Earth Science Information Network (Michigan, USA) http://sedac.ciesin.org/ <i>Human Interactions in the Environment</i>	2250 Pierce Rd. University Center, MI 48710 517-797-2727 517-797-2622 Internet: ciesin.info@ciesin.org
NOAA-SAA National Oceanic and Atmospheric Administration - Satellite Active Archive (Maryland, USA) http://www.saa.noaa.gov/ <i>Disciplines: Satellite Data (Atmosphere, Land, Ocean, Earth Sciences, Remote Sensing)</i>	NOAA/NESDIS Satellite Active Archive (Suitland, MD) 5627 Allentown Road, Suite 100 Princeton Executive Suites Suitland, MD 20746 NOAA-SAA User Services NESDIS/NCDC National Climatic Data Center 151 Patton Avenue Asheville, NC 28801-5001 USA 704-271-4850 voice Internet: saainfo@nesdis.noaa.gov

RACs - A list of current Regional Application Centers is provided in the below table. The goal of NASA's Regional Application Center Program (RAC) is to foster the self supporting use of environmental and Earth resources data (from satellites and other sources) by regional institutions in an effort to enhance knowledge of earth systems science. The RACs are a collaboration with NASA via a Memorandum of Understanding (MOU), receive no direct funding from NASA and are located regionally at universities with established remote sensing programs. The university RACs test NASA technologies in real-world applications, preferably in partnership with state and local agencies, universities, and value-added commercial companies, and provide feedback to NASA's satellite-derived data. The universities also provide their environmental data holdings to NASA for validation of satellite sensors and global climate change research.

RAC	
Bowling Green State University Attn: Robert Vincent Department of Geology Bowling Green OH 43403-0218	<u>Phone:</u> 419-372-0160 <u>Email:</u> rvincen@bgsu.edu
Clemson University Attn: Walt Ligon ECE Department 102 Riggs Hall P.O. Box 340915 Clemson SC 29634-0915 <u>Homepage:</u> http://ece.clemson.edu/parl/	<u>Phone:</u> 864-656-1224 <u>Email:</u> walt@eng.clemson.edu
Eastern Shore of Maryland Technical Center of Excellence (TCE), consisting of: WYE Research Laboratory University Maryland Eastern Shore Washington College Chesapeake College Talbot County, Maryland Talbot Chamber of Commerce 3DI Geographic Technologies Attn: Monty Deel	<u>Phone:</u> 410-820-4363, ext. 212 <u>Email:</u> mdeel@3DImaging.com
Florida International University Attn: Martha Gutierrez Spatial Data Processing Manager NASA Regional Application Center School of Computer Science, ECS 243 University Park Campus Miami FL 33199	<u>Phone:</u> 305-348-1706 <u>Email:</u> mgutie01@cs.fiu.edu
James Madison University Attn: Stephen E. Wright Center for Geographic Information Science Harrisonburg, VA 22807 <u>Homepage:</u> http://ntsl.csjmu.edu/nasa	<u>Phone:</u> 540-568-3154 <u>Fax:</u> 540-568-2761 <u>Email:</u> barnesjl@jmu.edu
Rutgers University Attn: Dr. Nabil R. Adam CIMIC 180 University Ave. Newark NJ 07102	<u>Phone:</u> 973-353-5239 <u>Fax:</u> 973-353-5003 <u>Email:</u> adam@adam.rutgers.edu

U.S. Naval Academy Attn: Randy Seftas 590 Holloway Road Aerospace Engineering Department Annapolis MD 21402-5042	<u>Phone:</u> 410-293-4380 <u>Email:</u> sertas@nadn.navy.mil
University of Cayuga County, NY Attn: Bob Brower 5th Floor County Office Building 160 Gcnesees Street Auburn NY 13021	<u>Phone:</u> 315-253-1276 <u>Email:</u> bbrower@relex.com
University of Hawaii at Manoa Attn: Norman Okamura Social Science Research Institute 2424 Maile Way, Porteus Hall 704 Honolulu HI 96822 <u>Homepage</u> http://www.mrtc.org/prvc/	<u>Phone:</u> 808-956-2909 <u>Email:</u> norman@elele.peacesat.hawaii.edu
University of Kansas Attn: Kevin P. Price Associate Professor, Geography & Associate Director Kansas Applied Remote Sensing (KARS) Program 2291 Irving Hill Road Lawrence KS 66045	<u>Phone:</u> 913-864-7723 (KARS) <u>Fax:</u> 913-864-7789 <u>Email:</u> kprice@falcon.cc.ukans.edu
University of Maryland - Baltimore County Attn: Tim Foresman Department of Geography 5401 Wilkens Avenue Baltimore MD 21228 <u>Homepage:</u> http://www.cs.umbc.edu/~motteler/research/rdc/index.html	<u>Phone:</u> 410-455-3149 <u>Email:</u> foresman@umbc.edu
University of Nebraska - Lincoln Attn: Don Rundquist Center for Advanced Land Management 113 Nebraska Hall Lincoln NE 68588-0517	<u>Phone:</u> 402-472-7536 <u>Fax:</u> 402-472-2410 <u>Email:</u> dr1000@tan.unl.edu
University of Southwestern Louisiana Attn: Margaret Francis Center for Advanced Computer Studies 2 Rex Street Lafayette LA 70504 <u>Homepage:</u> http://hvw.cacs.usl.edu/Departments/CACS/RVC/index.html	<u>Phone:</u> 318-298-6598 (24 Hour Number) <u>Email:</u> mmf@cacs.usl.edu
University of Southwestern Louisiana Ann: Duane Blumberg, Dean College of Sciences P.O. Box 43290 Lafayette LA 70504	<u>Phone:</u> 318-482-6986 <u>Fax:</u> 318-6195 <u>Email:</u> dblumberg@usl.edu